Application Number: 10/517,674
Amendment Dated: February 19, 2008
Reply to Office Action Dated August 17, 2007

LISTING OF THE CLAIMS

1. (previously presented) A method for charging an electrical storage device so as to extend the life thereof, the method comprising the steps of:

developing an essentialized cell model structure of the electrical storage device;

determining model parameters for charge-discharge data of the structure;

determining charge-discharge behavior of the structure in a voltage-charge plane;

measuring voltage values of the structure based upon the charge-discharge behavior; and

deriving an instantaneous damage rate from the measured voltage values.

2. (cancelled)

3. (previously presented) The method according to claim 1, further comprising the steps of:

developing a charging profile based upon the instantaneous damage rate, wherein the charging profile optimizes a charging current with respect to the damage per cycle so as to extend the overall life of the electrical storage device.

4. (previously presented) An optimal re-charging controller for an electrical storage device comprising:

a simulation processor receiving an input signal sent to the electrical storage device and a measured output signal generated by the electrical storage device, wherein the simulation processor models a plurality of states of the electrical storage device and generates an estimated output signal so that the controller mitigates damage to the electrical storage device, and wherein the simulation processor comprises:

a feedback component which receives the measured output signal and the estimated output signal to generate a correction signal; and

an observer component which receives the correction signal and the input signal to generate the estimated output signal and an estimated internal state signal,

wherein the estimated output signal converges a plurality of modeled dynamic states to corresponding states of the electrical storage device, and wherein the correction signal represents a real-time estimate of the amount of damage being done to the electrical storage device during re-charging.

5. (cancelled)

6. (cancelled)

7. (previously presented) The controller according to claim 4, wherein the damage rate sensor generates the estimated output signal such that a charging current applied to the electrical storage device is applied slowly at the beginning of the charge.

8. (previously presented) The controller according to claim 4, wherein the damage rate sensor generates the estimated output signal such that a charging current is applied more during a first half of a charging period than in a second half of the charging period.

9. (previously presented) The controller according to claim 4, wherein the damage rate sensor generates the estimated output signal such that a charging current applied to the electrical storage device is decreased slowly to zero amperes at the end of a charging period.

10. (previously presented) The controller according to claim 4, wherein the observer component contains model parameters of the electrical storage device which are updated as they change over the life thereof.

11. (currently amended) The controller according to claim 4, further comprising:

a damage rate sensor which receives the input signal, the estimated output signal and aid estimated internal state signal to generate a damage rate signal which estimates the amount of damage being done to the electrical storage device.

12. (previously presented) The controller according to claim 11, further comprising:

a supervisory intelligent controller for receiving the estimated internal state signal, the measured output signal, the damage rate signal and a desired performance input signal, wherein the supervisory intelligent controller generates a charging profile signal.

13. (previously presented) The controller according to claim 12, further comprising:

a battery control system for receiving the measured output signal, the estimated internal state signal and the charging profile signal to generate the input signal, wherein the battery control system adjusts the input signal to optimize charging of the electrical storage device to maximize the life thereof.

14. (new) The method according to claim 1, wherein the step of developing an essentialized cell model structure of the electrical storage device utilizes a hybrid cell model approach thereby permitting the method according to claim 1 to achieve real time observation of the charge state of the electrical storage device.

15. (new) The method of claim 14, wherein the hybrid cell model approach utilizes first principles dynamics.

16. (new) The controller according to claim 4, wherein the controller utilizes a hybrid cell model approach thereby permitting the controller according to claim 4 to achieve real time observation of the charge state of the electrical storage device.

17. (new) The controller according to claim 16, wherein the hybrid cell model approach utilizes first principles dynamics.